Portsmouth Vendor Forum

December 6, 2000

MSE, Inc.
P.O. Box 4078
200 Technology Way
Butte, Montana 59701

Presented by
Will Goldberg

- Small business
- 223 employees
- 70% professional/technical staff

MSE Project Team

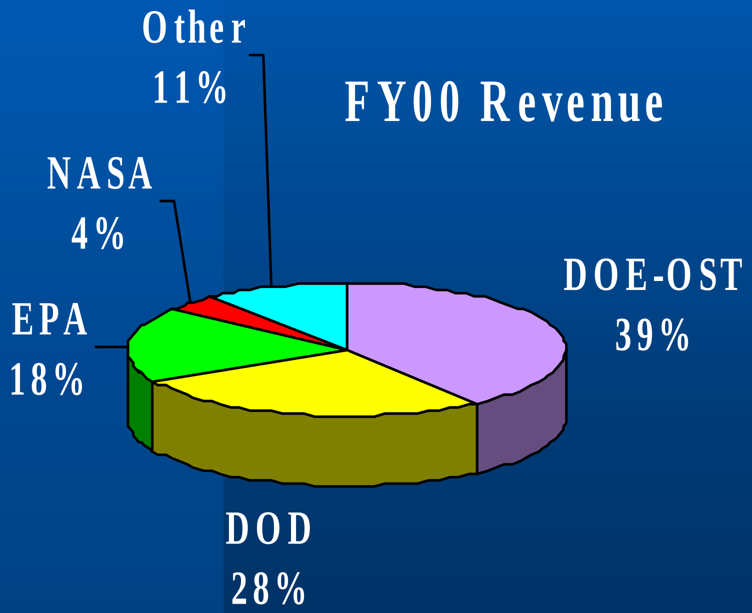
- Garth James, Ph.D. – MSE
- Randy Hiebert, P.E. – MSE
- Will Goldberg, P.E. – MSE
- Bill Costerton, Ph.D. – MSU, CBE
- Al Cunningham, Ph.D. – MSU, CBE
- Rob Sharp, Ph.D. – Manhattan College

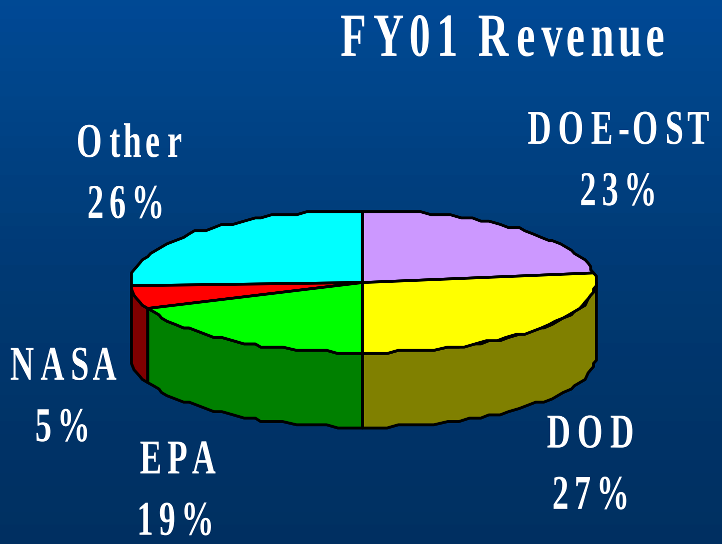
MSE Technology Applications

- Test Facility and Administrative Offices
  - 160,000 square foot facility built in 1978
  - Actual construction cost: $120 million plus
  - MHD program successfully concluded in 1993
  - Successful transition to multi-program facility
    - Department of Energy
    - Department of Defense
    - General Services Administration
    - Environmental Protection Agency
    - National Aeronautics Space Administration
    - Private

MSE Technology Applications

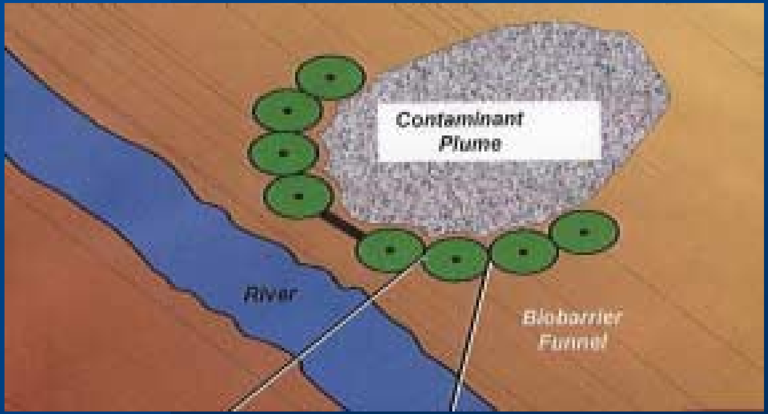
- Customer Base - $30-35 million





Containment/Stabilization Barriers

- Thin Grout Walls
- Viscous Liquid Barriers
- In Situ Vitrification
- Waste Stabilization
- Ultra Microbial Barriers



Control/Treatment

- Reactive Barriers
- Dense Non-Aqueous Phase Liquids (DNAPL)
- Solution Mining
- Phytoremediation

Environmental Containment and Control

- Supporting Work
  - Economic analysis
  - Economic evaluation needs
    - Life cycle cost modeling for environmental technologies and remediation systems
    - Cost benefit analysis
    - Risk analysis

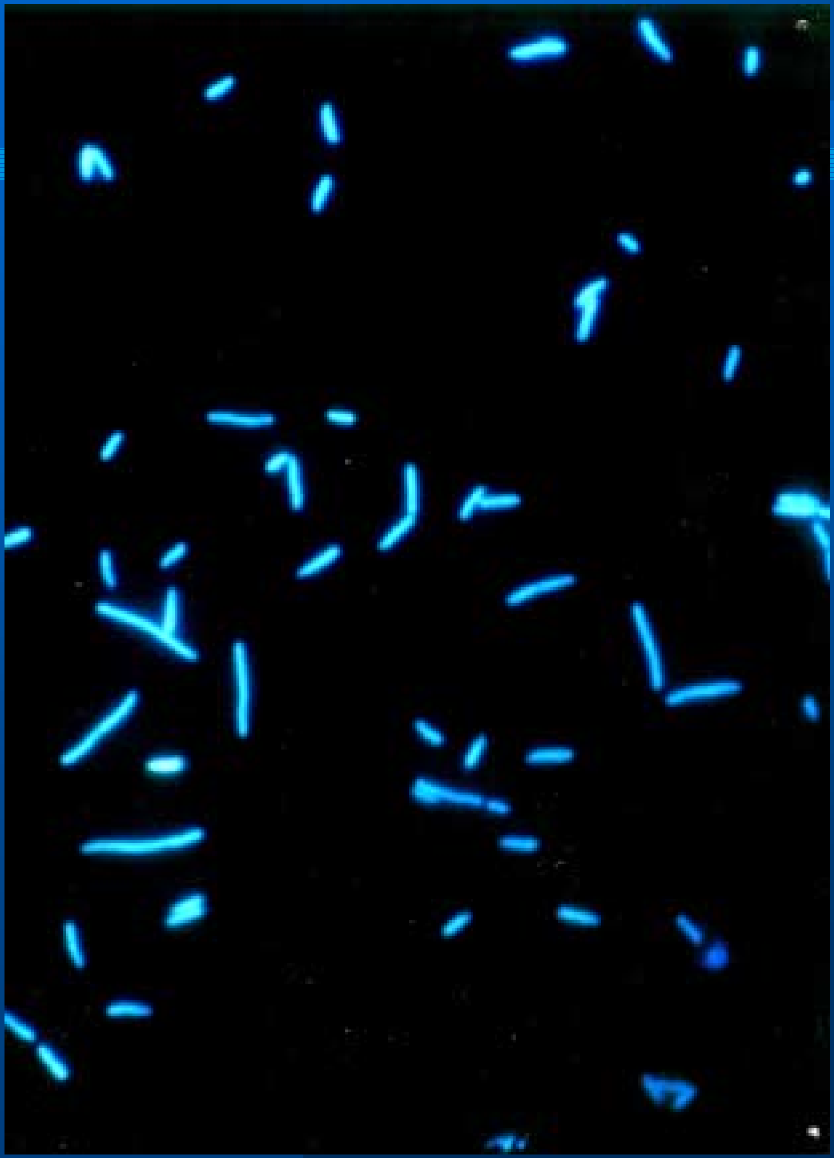

COMPLEX 34


Launch Complex 34 Engineering Support Building (ESB)
Chemical Oxidation Plot
Steam Injection Plot
Six Phase Heating Plot
High Pressure Sand Filter
$KMnO_4$ Mixing System
Dry $KMnO_4$ Hopper
Offgas Treatment System
Electrodes
Transformer

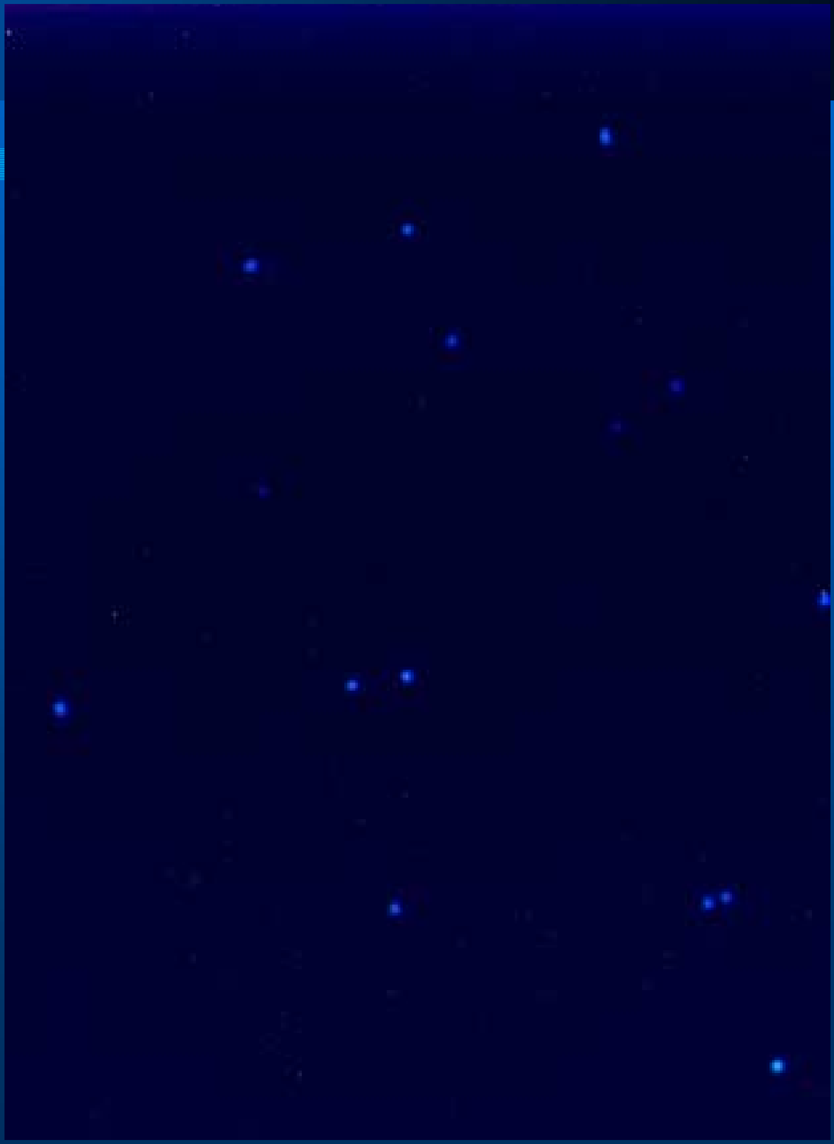
Starvation of Bacteria to Produce Ultramicrobacteria for Subsurface Injection

- Cell size reduction
- Able to withstand injection pressures to 1000 psi or higher
- Enhanced subsurface transport
- Enhanced survival

Full Size Bacteria



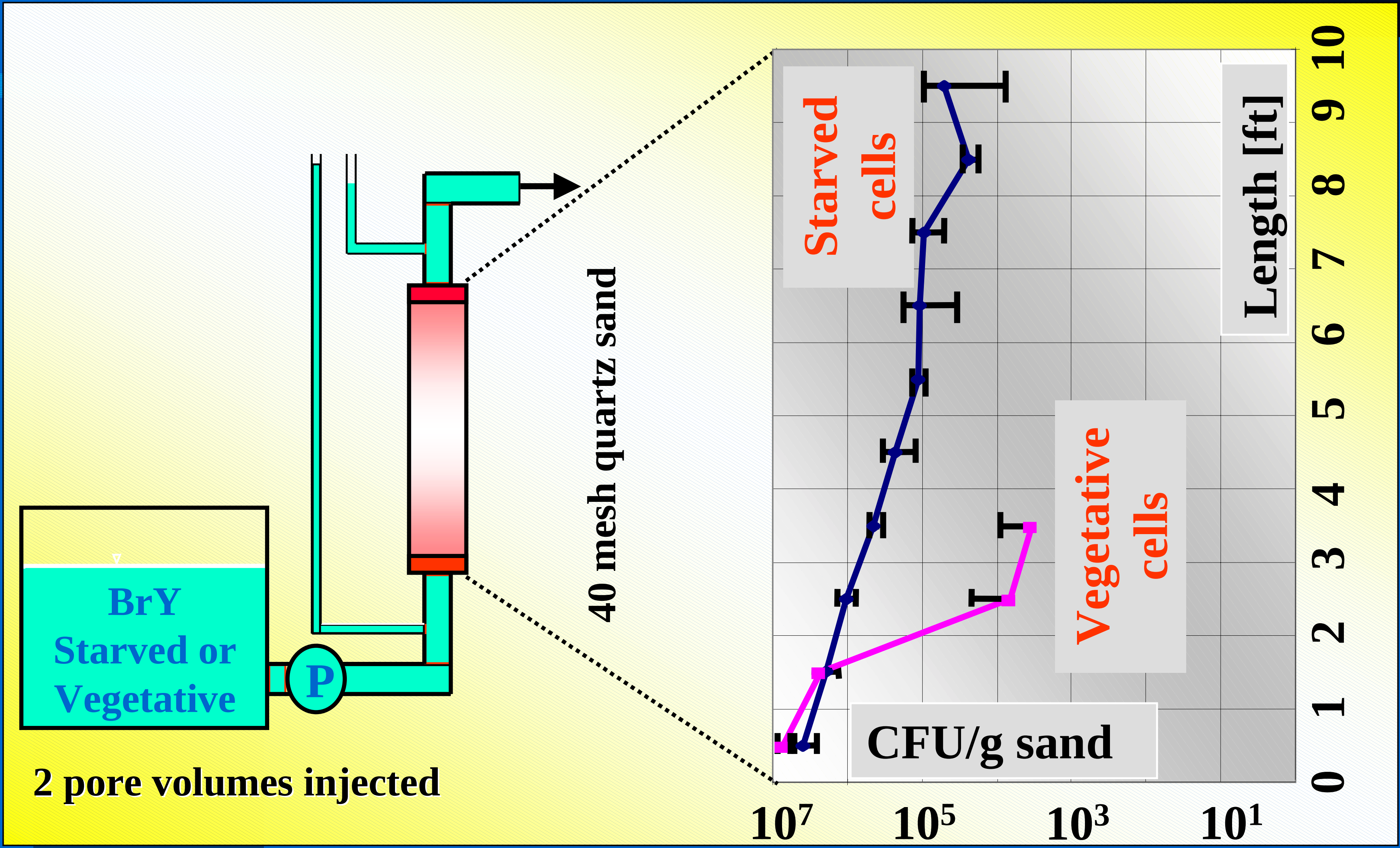
Ultramicrobacteria



UMB Transport Success

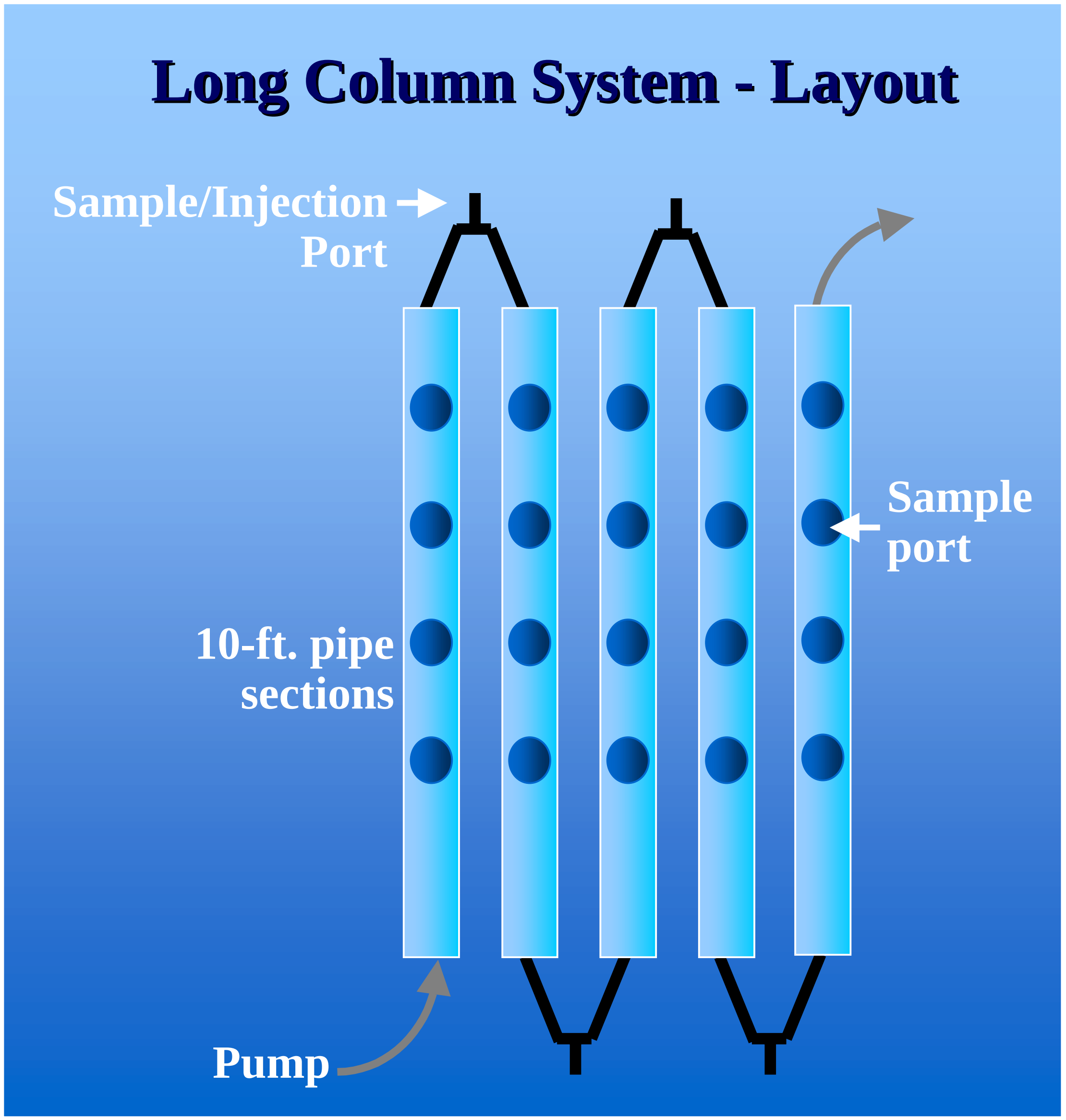
- 10 ft and 50 ft. columns (sand) - UMB vs. vegetative
- MEOR (sandstone) - Inject UMB at 1000 psi, recover over 0.25 mile away
- DOE columns - materials from seven locations throughout U.S. - 10^{-1} to 10^{-4} cm/sec

Distribution of Starved and Vegetative Cells at the End of Transport Experiment, 10 ft-Columns



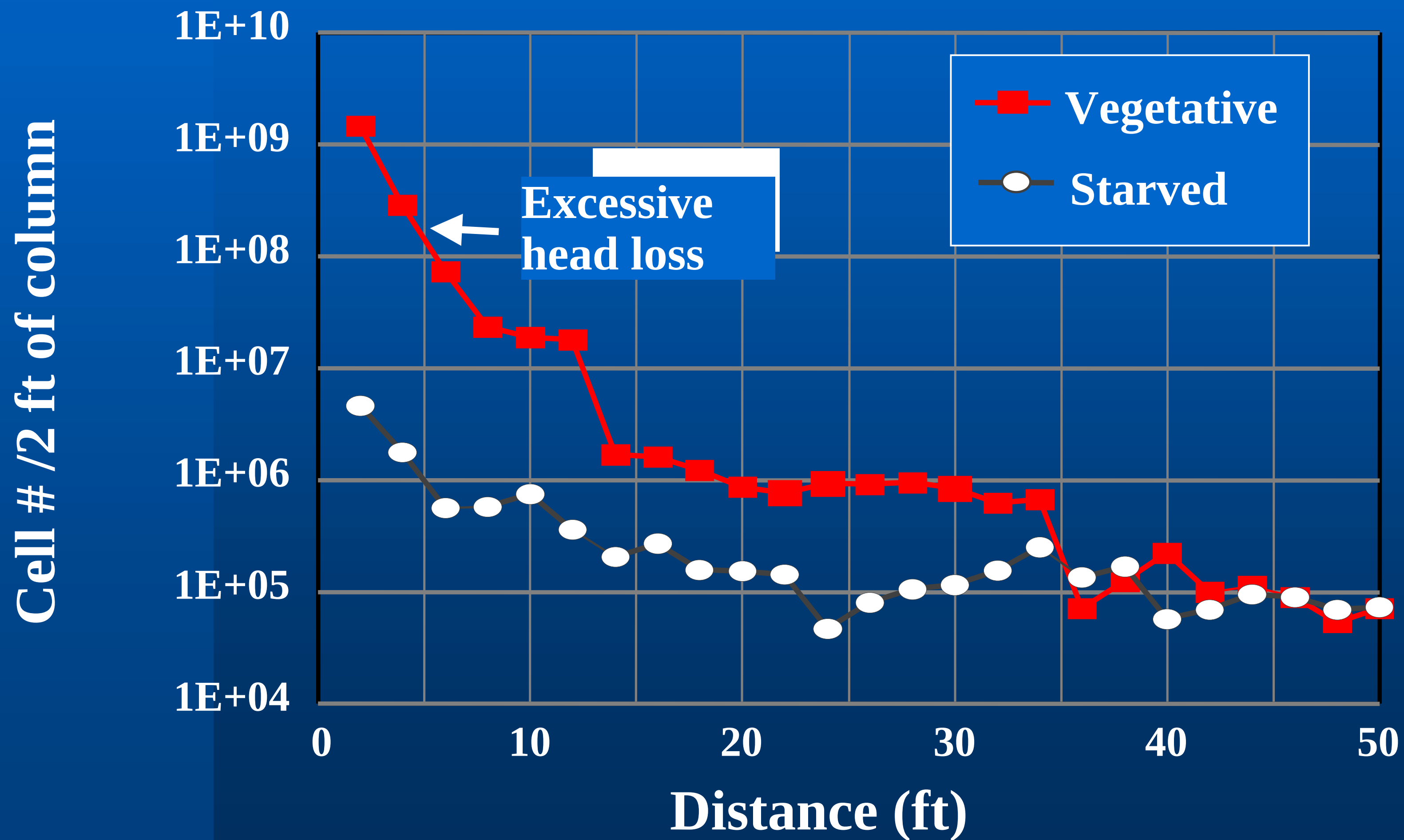
Long Column Studies

- 10 - 50 ft columns
- 2 - 4 in. dia. PVC pipe
- Packed with f-70 sand
- 3-6 months starved cultures of *K. oxytoca* (muccoid)
- Citrate nutrient feed



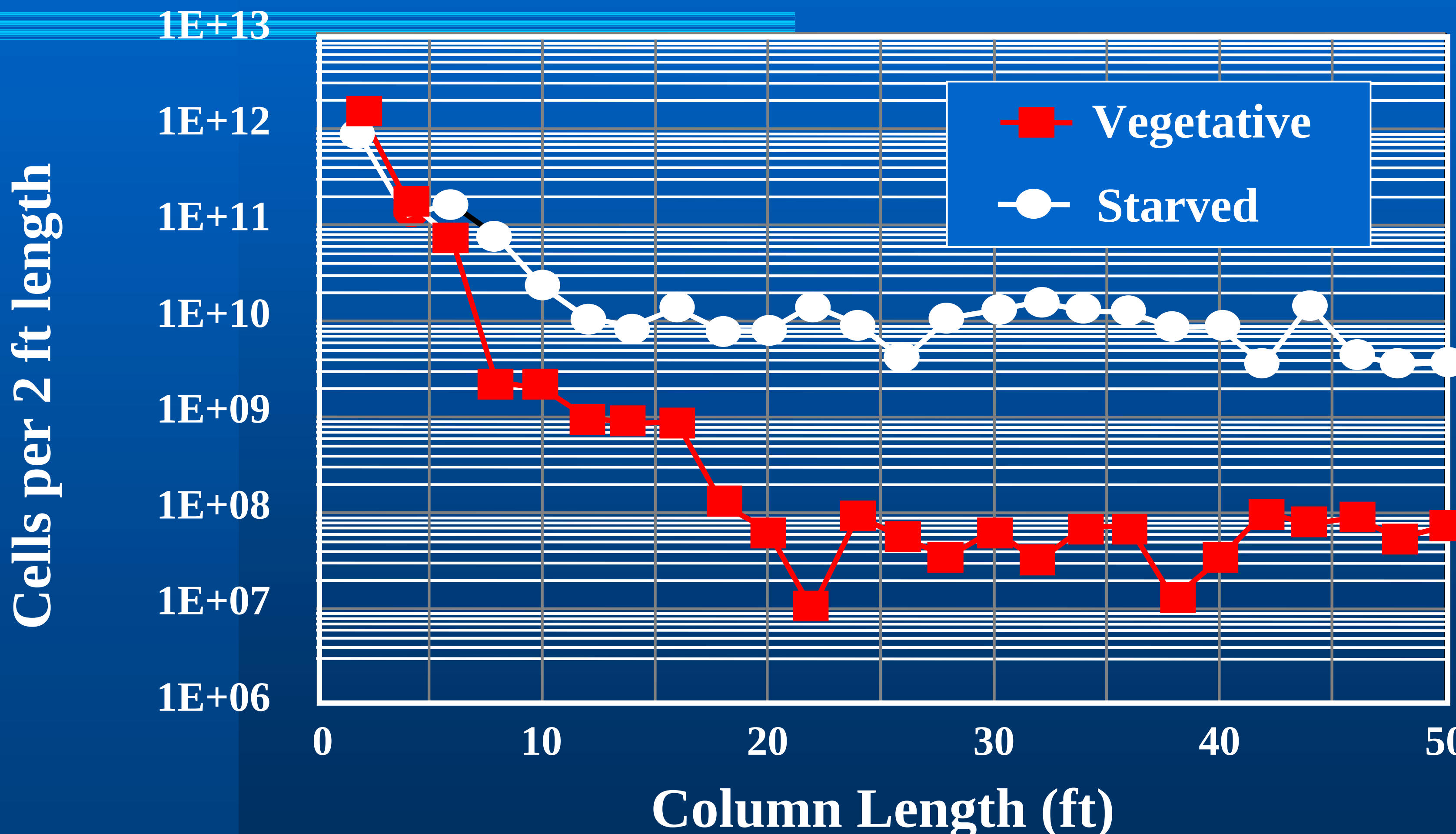
(R. Sharp Manhattan College)

Distributions of Starved And Vegetative Cells Along 50 ft Column: Prior to Nutrient Feed



(R. Sharp Manhattan College)

Starved and Vegetative Cell Distributions In Long Columns: After Nutrient Resuscitation



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Summary of Column Studies

- Percent cell volume reduction = 75%
- Recovery lag time = 48 to 104 hrs.
- Transportable distance > 50 ft.
- Percent breakthrough = 4 - 37%
- Percent *in-situ* cell recovery > 60% (est.)
- Flow reduction > 99%
- Hydraulic conductivity reduction =10^{-2} - 10^{-7}

(R. Sharp Manhattan College)

Portsmouth Approach for In Situ Bio degradation of TCE

Isolate Indigenous TCE Degrading Organism

Utilize Existing Proven TCE Degrader

Evaluate Selected Organisms Ability to be Starved and Resuscitated

Evaluate Groundwater Chemistry to Optimize Nutrient Formulation

Pilot Demonstration to Verify Transport Distances

Evaluate Delivery Options

Implement TCE Biodegradation